## REMARKS

Claims 13-38 are pending in the application. Claims 1-12 have been canceled without prejudice to Applicants' right to prosecute these claims in a timely filed divisional application.

In view of the following remarks, reconsideration and withdrawal of the rejections to the application in the Office Action is respectfully requested.

### *I. Rejection of Claims 13-15, 20-24, and 27- 28 under 35 U.S.C. § 103(a)*

In the Office Action, Claims 13-15, 20-24, and 27-28 were rejected under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 3,058,854, issued to Angello (hereinafter "Angello") in view of U.S. Patent No. 5,363,796, issued to Kobayashi *et al.* (hereinafter "Kobayashi") and U.S. Patent No. 5,132,091, issued to Azad (hereinafter "Azad"). Applicants respectfully traverse.

In order to establish a *prima facie* case of obviousness, the prior art references, alone or in combination, must teach or suggest all of the claim limitations. In addition, there must be some suggestion or motivation to modify the references or to combine reference teachings. (MPEP §2143) The mere fact that references can be combined or modified does not render the resulting combination obvious unless the prior art also suggests the desirability of the combination. (MPEP §2143.01) It is impermissible to rely on hindsight based upon Applicants' own disclosure in establishing a *prima facie* case of obviousness. (MPEP §2142) The combined teachings of Angello, Kobayashi and Azad do not render the rejected claims unpatentable under 35 U.S.C. §103(a) because the cited references do not provide any suggestion or motivation to modify the teachings of Kobayashi to include a baffle between two heaters as disclosed in Azad.

In the Office Action, it was conceded that the combination of Angello and Kobayashi does not teach an apparatus having an insulator positioned between an upper and lower heater. However, the Office Action states,

> It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Angello and Kobayashi with Azad's baffle between two heaters to concentrate the heat of a lower heater below the level of the baffle.

However, the Office Action fails to indicate any language in the cited references that suggests the desirability of using a baffle to concentrate the heat of the lower heater in Kobayashi below the level of the baffle.

Kobayashi teaches an apparatus for growing a single crystal that includes a main heater and a sub-heater facing a zone in which a crucible moves vertically. The two heaters are separated by a pre-determined distance along the vertical direction. (Col. 7, lines 19-26.) The main heater is positioned around a melt layer below the top of the crucible and the sub-heater is positioned around an underlying solid layer above the bottom of the crucible. (Col. 8, lines 45-48; Col. 8, lines 55-61; Fig. 4.) Kobayashi teaches that both the main heater and the sub-heater may be powered on as a crystal is pulled from the contents of the crucible in such a way as to satisfy the non-segregation condition. (Col. 12, lines 60-63.) Kobayashi describes this process as follows:

> It is necessary to change the outputs of the main heater **32** and sub-heater **33** with the passage of time so as to satisfy the non-segregation condition in the variable-thickness melted layer method which is indicated by the aforementioned equation (10).

Equation (10) provides an expression for the non-segregation condition. However, the Office Action does not point out, and Applicants are unable to locate, any language in Kobayashi suggesting that in order to satisfy the non-segregation condition according to Equation (10), it would be desirable to include a baffle between the main heater and the sub-heater. Nor is any such suggestion provided by Azad.

Azad teaches an apparatus and method for controlling the shape of the peripheral edge region of a crystal formed by the Czochralski method. The apparatus of Azad includes a crucible which is heated by a first heater that controls the bulk thermal properties of a melt in

the crucible and a second heater located above the first heater. The second heater is disposed above the level of the melt in the crucible to control the thermal conditions at the peripheral edge region of the solid interface of a crystal being grown. (Col. 3, lines 10-17.) The second heater directs heat to the target region at the peripheral edge of the solidification interface and is independently controllable from the first heater. (Col. 5, line 67 through Col. 6, line 10.) In one embodiment of the Azad apparatus, an annular baffle is provided below the second heater at the level of the top surface of the melt in order to concentrate the heat generated by a third heater, which is disposed beneath the bottom of the crucible, below the level of the baffle. (Col. 4, line 66 through Col. 5, line 2.) Thus, Azad teaches an apparatus that includes a baffle between a first and a second heater that is used to concentrate the heat of a third heater below the solidification interface of a growing crystal. Azad does not suggest the desirability of including an insulator between two heaters in order to concentrate the heat of the lower heater below a melt layer in a crucible. Therefore, the cited references fail to provide any suggestion or motivation to modify the apparatus of Kobayashi to include the baffle of Azad. For this reason, Applicants respectfully request that this rejection be withdrawn.

### *II. Rejection of Claims 16-19, 21, 25-26, and 29-37 under 35 U.S.C. §103(a)*

In the Office Action, a number of references were combined with Angello, Kobayashi, and Azad in order to support claim rejections under 35 U.S.C. §103(a). Claims 16-19, 29-35, and 37 were rejected as unpatentable over Angello, Kobayashi, and Azad in view of U.S. Patent No. 4,609,530, issued to Morioka *et al.* (hereinafter "Morioka"). Claims 25 and 26 were rejected as unpatentable over Angello in view of Kobayashi and Azad and further in view of an article from the *Journal of Crystal Growth*, published in 1998, and authored by Lin *et al.* (hereinafter "Lin"). Claim 36 was rejected as unpatentable over Angello, Kobayashi, and Azad in view of Morioka and Lin. Claim 21 was rejected as unpatentable over Angello, Kobayashi, and Azad in view of U.S. Patent No. 4,013,501, issued to Van Uitert *et al.* (hereinafter "Van Uitert"). Claim 37 was rejected as unpatentable over Angello, Kobayashi, Azad, and Morioka in view of Van Uitert. Applicants respectfully traverse.

Each of Claims 16-19, 21, 25-26, and 29-37 depend from independent Claim 13 or independent Claim 29, both of which disclose a method for carrying out Czochralski crystal growth by heating an upper portion of a crucible with an upper heater and heating a lower portion of a crucible with a lower heater wherein an insulator is positioned between the upper heater and the lower heater. As discussed above in Section I, the combination of Angello, Kobayashi, and Azad fail to provide any suggestion or motivation to modify the apparatus of Kobayashi to include the buffer of Azad. Morioka, Lin, and Van Uitert also fail to provide such a suggestion or motivation. Therefore, Claims 16-19, 21, 25-26, and 29-37 are patentable over the cited references for each of the reasons discussed in Section I and Applicants respectfully request that this rejection be withdrawn.

### *III. Rejection of Claim 38 under 35 U.S.C. §103(a)*

In the Office Action, Claim 38 was rejected under 35 U.S.C. §103(a) as unpatentable over Angello in view of Kobayashi and Azad. Applicants respectfully traverse.

As noted above, in order to establish a *prima facie* case of obviousness, the cited references, alone or in combination, must teach each and every limitation of the rejected claim. None of the cited references teaches or suggests a method for carrying out crystal growth that includes the step of cooling a melt under conditions which allow the melt to become undercooled and to solidify rapidly, minimizing macrosegregation in the resulting solid feed material, as recited in rejected Claim 38. The Office Action states,

> The combination of Angello, Kobayashi *et al* and Azad is silent to cooling the melt under conditions, which allow the melt to become undercooled and to solidify rapidly, minimizing macrosegregation in the resulting feed material.

However, the Office Action goes on to assert that this process would be inherent to the combination of Angello, Kobayashi, and Azad because Kobayashi teaches cooling the melt by turning off the sub-heater which is lower than the lower end of the inner crucible. Applicants respectfully submit that the Office Action has mischaracterized the teachings of Kobayashi.

Kobayashi teaches an apparatus for growing a single crystal that involves the step of completely melting a silicon polycrystal in a crucible using a main heater to heat an upper portion of the crucible and a sub-heater to heat a lower portion of the crucible. (Col. 9, lines 10-16.) In the apparatus of Kobayashi, the lower end of the sub-heater is lower than the lower end of the inner crucible, but the upper end of the sub-heater is higher than the lower end of the inner crucible. (Col. 8, lines 55-61 and Fig. 4.) Once all of the silicon polycrystal is melted, the power to the sub-heater is turned off to allow a solid layer to grow in the lower portion of the crucible. (Col. 9, lines 17-20.) Kobayashi does not discuss withdrawing the crucible from the sub-heater in order to facilitate rapid solidification. In fact, Kobayashi describes the gradual formation of the solid layer as follows:

> According to the present invention, the whole of the raw material is charged into a crucible **31**, is melted using the main heater **32** and the sub-heater **33**, and the molten material is *gradually solidified* along the direction from the bottom of the crucible **31** toward the upper portion thereof to form a solid layer S of polycrystal . . . (Col. 9, line 65 - Col. 10, line 2.)
>
> (Emphasis added.)

Thus, Kobayashi teaches a method that includes the step of completely melting a solid feed material, followed by the gradual and directional solidification of only the lower portion of the melt. In contrast, Claim 38 recites a method for carrying out crystal growth that includes the steps of melting a solid feed material, cooling the melt under conditions which allow the melt to become undercooled and to *solidify rapidly*, minimizing macrosegregation in the resulting solid, and subsequently heating the upper portion of the resulting solid to a temperature sufficient to provide a melt. An advantage to this method is described on Page 9, lines 26-30, of the pending application, which explains, "An undercooled melt tends to freeze instantaneously, leaving no time for solute segregation to develop over a long distance that is comparable to the crucible dimension. This rapid solidification is different from directional solidification, which does not reduce macrosegregation." Thus, the pending application clearly distinguishes the rapid solidification of an undercooled melt from the gradual and directional solidification described by Kobayashi. For this reason, Applicants respectfully

submit that Claim 38 is patentable over the combination of Angello, Kobayashi, and Azad and respectfully request that this rejection be withdrawn.

In view of the foregoing remarks, Applicants respectfully submit that all of the claims remaining in the application are in condition for allowance and favorable action thereon is respectfully solicited.

Respectfully submitted,

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